

UCRL-JC-134156

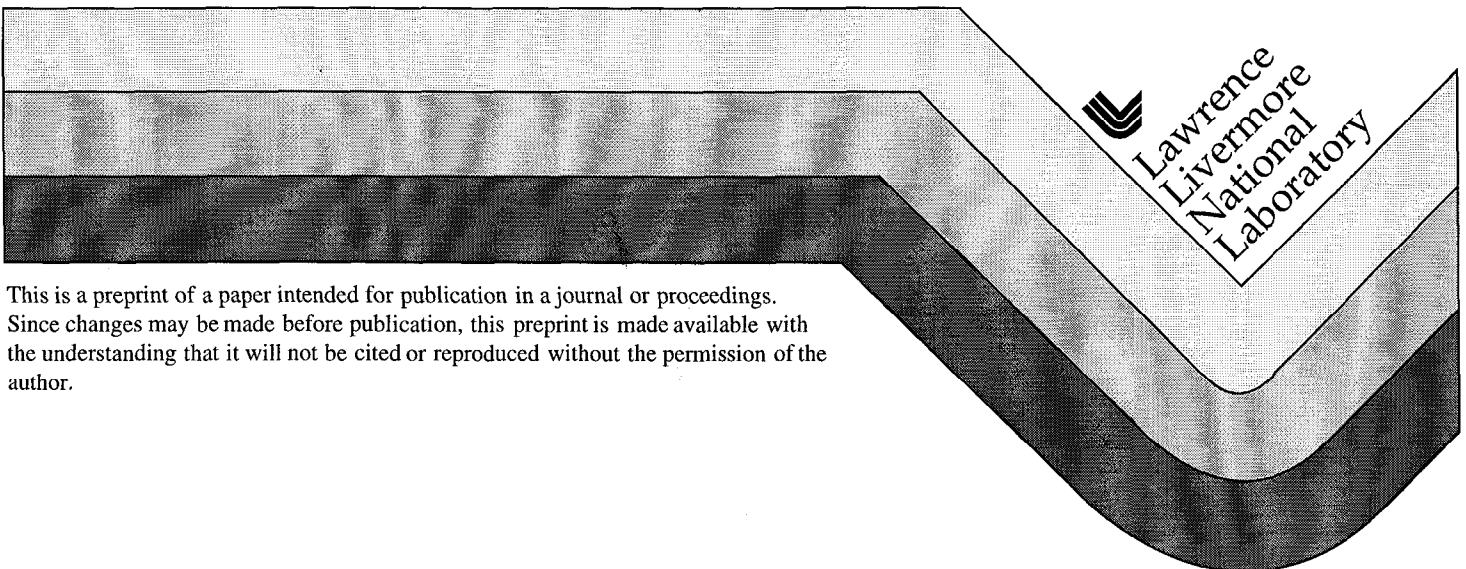
PREPRINT

A New Approach in Utilizing a Computer Data Acquisition System for Criticality Safety Control

H. Hopkins
S.T. Huang
F. Warren

This paper was prepared for submittal to the
Sixth International Conference on Nuclear Criticality Safety
Versailles, France
September 20-24, 1999

May 6, 1999



DISCLAIMER

This document was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor the University of California nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial products, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or the University of California, and shall not be used for advertising or product endorsement purposes.

A NEW APPROACH IN UTILIZING A COMPUTER DATA ACQUISITION SYSTEM FOR CRITICALITY SAFETY CONTROL

Harvey Hopkins, Ph.D.
Song T. Huang, Ph.D.
Fred Warren
Lawrence Livermore National Laboratory

Abstract

A new approach in utilizing a computer data acquisition system is proposed to address many issues associated with criticality safety control. This Criticality Safety Support System (CSSS) utilizes many features of computer and information process technology such as digital pictures, barcodes, voice data entry, etc. to enhance criticality safety in an R&D environment. Due to on-line data retrieving, data recording, and data management offered by new technology, the CSSS would provide a framework to design new solutions to old problems. This pilot program is the first step in developing this application for the years to come.

Introduction

Lawrence Livermore National Laboratory (LLNL) carries out a wide variety of research and development activities with significant amounts of unencapsulated fissile material as part of its national security mission. Compliance with government regulations, national standards, and laboratory policies mandate the need to maintain an acceptable margin of criticality safety in these activities. The uniqueness of the Laboratory's research and development environment is that virtually all activities with fissile material are one-time operations in which the parameters important to criticality safety are seldom the same. As such, decisions regarding the criticality safety of an operation involve a changing environment and are made based on meeting a set of criticality safety limits (often unique to a single activity) developed by the Laboratory's Criticality Safety Group. Operating personnel involved in the handling of the fissile material must decide whether an operation can be carried out safely based on these limits and work control process. Computer-based decision-making aids currently exist based on tracking fissile material mass. Evaluations of other criticality safety parameters are based on operator knowledge and by administrative aids such as reminder cards posted near each work area.

The double contingency principle and defense-in-depth approach is a key cornerstone in implementing criticality safety at Lawrence Livermore National Laboratory. In our operations, a two-person rule is used in conjunction with computer assistance to allow the technician to control aggregate fissile mass within criticality safety limits. This real-time computer-assisted mass control method has proven to be a valuable tool in assisting criticality safety control implementation in our facilities. As computer technology continues to evolve, it was realized that additional utilization of the computer software and data acquisition hardware features should be very valuable in enhancing criticality safety. A pilot project, called the Criticality Safety Support System (CSSS), is being designed and carried out to explore application of new computer technology for enhancing criticality safety controls in an R&D environment. This paper describes the motivation for, and features of this innovative approach.

Existing Criticality Safety Tracking System

At LLNL, simple mass controls mesh well with material protection, control and accountability requirements through which we maintain a detailed computer database of the fissile material mass and assay of all material. This database is used for criticality safety purposes to compare the amount of fissile material in a work area ("workstation") against a mass limit whenever it is proposed to place additional fissile material in the workstation. The existing computer database was built upon material control accountability needs and is functioning extremely well in controlling fissionable material mass. Other criticality safety parameters such as moderator types and amounts, geometry controls, and reflector/cladding controls are currently evaluated by the operators based on their knowledge and inspection of the workstation under administrative control.

Motivation for the Criticality Safety Support System

As computer technology advanced, it was desired to provide a backup to operator knowledge and judgement in the evaluation of the multiple criticality safety controls. Advances in the ease of populating, manipulating and updating a database with the information necessary to make criticality safety decisions makes it practical to have a robust backup to operator evaluations. User-friendly graphical interfaces for the entry and display of applicable information are facilitated using web browser software that can be configured to meet specific situations. Data input can be eased using pre-configured menus and automatic entries from mass scales, digital cameras, barcodes, or any other instrumentation with an interface to a personal computer.

Another motivation for enhanced computer decision-making aids in the research and development environment is that many operations are unique and may have custom criticality controls, which although similar to other sets of controls, may differ in some aspect. It is important in criticality safety that our operators know the controls that are in effect for each operation and a computer database system is able to provide the proper backup to even the most experienced operator.

CRITICALITY SAFETY APPLICATION

Criticality Safety Capabilities

The CSSS system will compare criticality parameters of items being transferred with the criticality limits of the proposed destination and indicate to the material handlers that inclusion of the material would or would not be allowed. Additionally, workstation specific controls would be included in the determination. This same check would be provided in the workstation area for transfers into and between workstations. The material types that will be tracked would include any liquids, key moderators, and reflectors. The system will not attempt to keep a total inventory of all material in a workstation due to the difficulty of keeping the inventory accurate. This is particularly true for liquids that either may evaporate or be consumed as part of the processing within the workstation.

Criticality Information

For each fissile package (such as a can, an approved item, or a bagged piece without a container), the CSSS system will maintain and provide pertinent data on material identification for the item. The following information will be available and will be maintained in the CSSS system: part description, fissile material mass, reflector and moderator information, isotopic information, and packaging material information.

Criticality Safety Check Prior to a Move

When an item that has criticality safety data associated with it needs to be moved from one area to another, the material handler will access the CSSS computer system to determine the appropriateness of the move. At least initially, the handler will access the material tracking system and check if the mass of the item will be allowed into the target area or workstation. If the item passes this test, the handler will then access the CSSS system to see if the item is acceptable to the target workstation under the prevailing criticality limits and special conditions in force for the workstation. This checking will lend additional support to the current communication between the material handler and the workstation owner.

Reports and Audits

Complete records of all items entered into the CSSS will be maintained and reports will be provided to allow for retrieving this information and printing it out. On-demand report capability will be available to support management requirements and audits. Specific report formats will be developed over the duration of the project. It will be easy for the facility to implement additional reports over time.

OPERATOR TRAINING

The CSSS system will provide a real working environment for training fissionable material handlers. The CSSS system provides valuable fissile package information to assist the operators in doing their work safely. The system can be operated off-line to allow the required on-the-job training for new operators.

Criticality Safety Support System Project Status

The LLNL Criticality Safety Support System (CSSS) project is an operational pilot computer system designed to explore and verify the practicality of supporting criticality safety in the LLNL Plutonium Facility. Included, in this effort is the extension of a network to each laboratory in the facility along with the installation of NT class computers (four locations) to implement the criticality support process. A schematic of the system is shown in Figure 1. Other technologies, such as barcoding, digital photographing of items, voice data entry, digital measurement from electronic scales, and document management of important facility documents will be explored within budget and time constraints. It is the project goal to field this pilot capability in the Plutonium Facility by the end of March 2000. Figure 2 is an example of the appearance of the CSSS's graphical user interface.

Subsequent to fielding the pilot system, the project will evaluate the operation, modify the operation where needed, and prepare a proposal for converting the pilot system into a full production system. Support for the conversion to a production system will require activities on an on-going basis once the decision to implement the production system is made.

Features of the CSSS

The purpose of the CSSS system is to collect information about items handled in the Plutonium Facility and use this information to help determine whether a specific item can be introduced into a specific workstation. Activities for this process take place at several stages of the handling of an item. Several CSSS computers may be involved in this process from its start to completion.

Data Collection and ES&H Label Printing

When an item is placed in a container and an Environmental Safety and Health (ES&H) label is required; a Material Handler will access the material tracking system and the CSSS system from the CSSS computer. He will first enter information into the material tracking system. This information will include such items as the serial number, mass, isotope(s), etc. When the material tracking transaction is complete, the CSSS system will be accessed via a software window on the same CSSS computer. Here a "fill in the blanks" form is used to enter the information required for the ES&H label as well as any supplementary information that is required for tracking the item.

Once the required information has been entered into the CSSS computer, the operator may request the printing of the ES&H label. These labels are then affixed to the container item. Presently, material handlers manually fill the ES&H label out which requires extra time and effort.

Digital Pictures of Items

The project will also investigate the use of digital cameras to capture electronic pictures of items and store them with the criticality data about the item. These pictures can be retrieved at any time to help identify the items in containers.

Barcoding of Items

We expect, the materials tracking system will be modified to create and use barcodes similar to those produced by the CSSS system in order to reduce the amount of data entry required to process items through both systems. There are significant operational and procedural issues that must be resolved to allow for barcoding.

Voice Data Entry

Current technology now makes it possible to enter information into a desktop computer system by voice. This technology is not perfect and there are some difficulties in using it, but it may prove useful to the CSSS system. In particular, entry of numeric data during the processing of an item into a workstation requires that the operator removes his hands from the glovebox and accesses the computer terminal. This is a time consuming process, particularly for a very short entry step. It may prove possible to use voice entry for this kind of data entry, which will be investigated.

Direct Connection to Digital Scales

Several laboratories in the Plutonium Facility operate scales to determine the weight of items that they process. It would reduce data entry errors and perhaps improve efficiency if the measurement data from the scales could be read directly by the computer system(s). The CSSS project will attempt to interface to one or more digital scales. The feasibility of this application will be investigated.

Document Management

The central CSSS server will provide a point of storage and access for documents needed to support the operations of the facility. Typical documents would be the Operational Safety Plans of all the workstations, the Facility Safety Plan, etc. With easy to use access to electronic versions of these documents from any CSSS computer, time is saved and reference easily made during actual work performance. In addition, the central storage allows for the most current version of the documents to be available every where. This document management system provides the required training and information support that is normally part of an Enhanced Performance Support System, which the CSSS system is providing.

CONCLUSION

The CSSS system implements several capabilities which act together to enhance safety in the handling of nuclear materials. This new approach includes the use of barcode labeling to aid in the automatic tracking of material and objects and the use of a distributed computer network to allow data entry and retrieval at important points in the handling process. Digital pictures will be taken and

stored with the criticality safety data to aid in later analysis and inventory procedures. We also are integrating Electronic Performance Support Systems (EPSS) technology into the system to facilitate compliance with criticality safety procedures. EPSS provides a structured, guided execution of a process. We combine this with a web-based document management system to provide immediate search and access capabilities to important defining procedures and documents.

The process begins with either new material entering our site or legacy material being withdrawn from our materials storage vault. The material is identified and important mass tracking information and criticality safety data is entered into a Windows NT workstation which then splits the information into two groups and forwards it to either the mass tracking database or the criticality database. By keeping these two databases separate information can be protected in a graded manner. A sticker is generated that contains this information and it is attached to the physical object or its container. A barcode is also generated to identify the object and it is included as part of the sticker. The system will provide barcode tracking for both objects and containers, with information on both residing in one or both of the databases. A digital picture can be taken of the object and stored with the criticality information in the database for retrieval later.

When an object is routed to one of our laboratories for use in an experiment or operation, the barcode is scanned by a local Windows NT workstation and the mass and criticality safety information is retrieved from the central databases. This information is used to support a question and answer process that guides the user through the criticality safety determination. Other factors that are included are the operational environment that the object will be placed in. This step-by-step process is central to the principles of the EPSS technology used in implementing the controlled guidance. Should the operator need supplementary information, access to the document management system is readily available via a web-based interface.

Given the tremendous data acquisition capabilities provided by new computer technology, this approach offers a new horizon of looking at the old issues. Due to on-line data retrieving, data recording, and data management capabilities offered by new technology, we are equipped with better tools and information to establish new solutions to old problems. In this regard, we are firmly convinced that this pilot program is the first step in developing this application for the years to come. From preliminary assessment of the potential application of this system, benefits of this approach will include improvement in many elements of criticality safety programs such as conduct of operations, operator assistance on a real-time basis, enhancing two-person rule in controlling parameters, material transfer, waste management, operator training, and simplification of criticality safety controls. Furthermore, unsafe material transfers prevented on a real-time basis by software will be a real safety improvement. For the next few years, we plan to test out this approach in an R&D working environment.

Figure 1. CSSS schematic

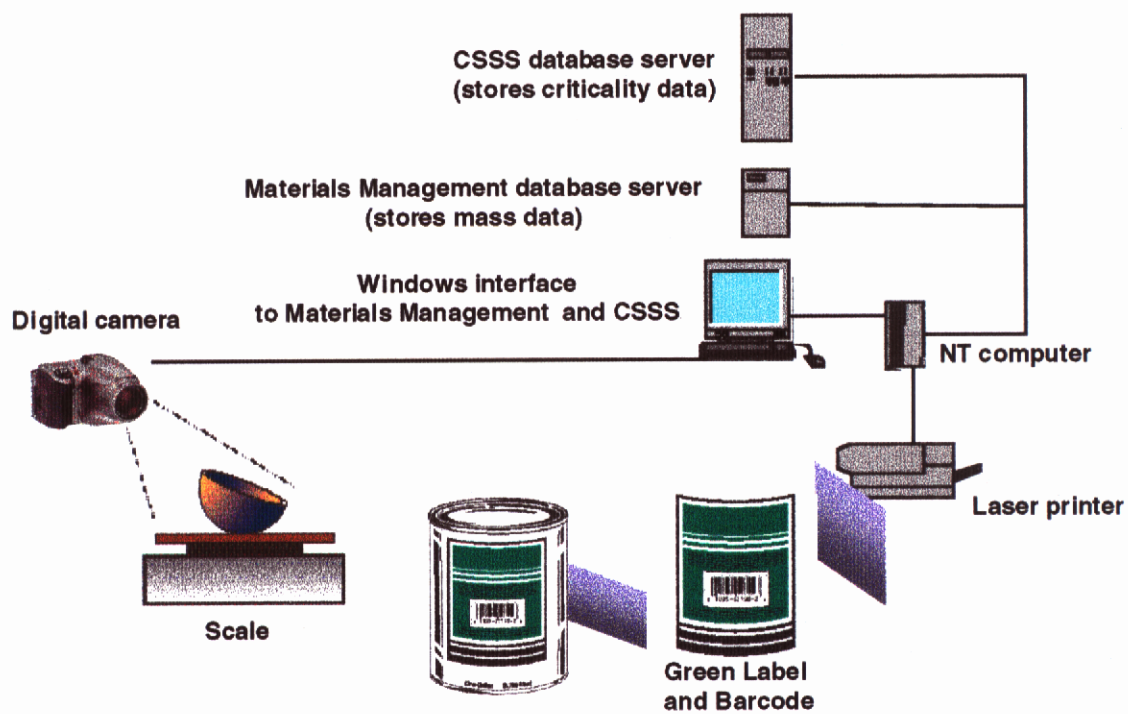


Figure 2. CSSS graphical user interface

